RACKING SYSTEMS AND RELATED METHODS

Field of the Invention

The present invention relates generally to racking systems. More particularly, this invention relates to racking systems for panels. Also provided are methods of making, configuring (e.g., assembling and/or adjusting), and using racking systems.

Background of the Invention

Laminated glass is widely utilized in industry, most notably for motor vehicle windshields and other safety glass. Generally, laminated glass comprises two sheet-like substrates (e.g., glass sheets) and an interlayer (e.g., a tear-resistant plastic) positioned between the two substrates. An advantageous characteristic of laminated glass is that, when impacted by an object, laminated glass tends to retain its overall structural integrity while reducing the occurrence of flying glass resulting from breakage. Using laminated glass for motor vehicle windows, for example, helps ensure the safety of drivers and passengers in the event of an accident. Similarly, using laminated glass in other safety glass applications (hurricane glass, blast-resistant glass, etc.) helps ensure the safety of bystanders.

Generally, the manufacture of laminated glass is known to involve an assembly operation and an autoclave operation. In the assembly operation, the interlayer is positioned between two glass substrates to form a sandwich, which is then heated (commonly to a temperature of between about 120 °F and about 170 °F) and roller pressed to initiate removal of air trapped within the interlayer and to initiate adhesion of

the interlayer to the glass. In the autoclave operation, the sandwich is exposed to an elevated temperature (commonly between about 275 °F and about 300 °F) and an elevated atmospheric pressure (commonly between about 150 psig and about 190 psig) until there is complete adhesion of the interlayer to the glass and complete dissolution of air trapped within the interlayer. It is common for the autoclave operation to last two hours or four hours per treatment.

Conventional autoclave methods are batch processes. As such, only a certain batch size (e.g., one or more racks carrying laminated glass panels) can be processed within the chamber of an autoclave. Therefore, it is desirable to maximize the number of laminated glass panels that can be autoclaved in a single batch.

It would be desirable to provide racking systems and related methods that allow the batch size in autoclave processing to be maximized for panels of various different sizes and shapes. It would be particularly desirable to provide racking systems and related methods that offer as much flexibility as possible in terms of being adjustable or otherwise configurable in numerous different ways.

Summary of the Invention

Certain embodiments of the invention provide a rack for storing generally sheet-like panels. The rack comprises a generally horizontal base, a generally vertical central wall, one or more separating tiers, and one or more supporting tiers. The generally vertical central wall extends upwardly away from the base. The rack has panel storage areas on both sides of the central wall. Each panel storage area is adapted to retain a plurality of panels each positioned generally parallel to the central wall and generally

perpendicular to the base. The one or more separating tiers are each defined by one or more generally horizontal separating planks extending away from the central wall and being adapted to retain upper edge regions of panels stored in the rack. The one or more supporting tiers are each defined by one or more generally horizontal supporting planks extending away from the central wall and being adapted to support lower edges of panels stored in the rack.

Additionally, certain embodiments of the invention provide a method of providing storage for generally sheet-like panels. The method comprises providing a rack comprising a generally horizontal base and a generally vertical central wall. The generally vertical central wall extends upwardly away from the base. The rack has panel storage areas on both sides of the central wall. Each panel storage area is adapted to retain a plurality of panels each positioned generally parallel to the central wall and generally perpendicular to the base. One or more generally horizontal separating planks are attached to the central wall, such that each separating plank extends away from the central wall and is adapted to retain upper edge regions of panels stored in the rack.

Also, certain embodiments of the invention provide a method of storing generally sheet-like panels. The method comprises providing a rack comprising a generally horizontal base, a generally vertical central wall, one or more generally horizontal separating planks, and one or more generally horizontal supporting planks. The generally vertical central wall extends upwardly away from the base. The rack has panel storage areas on both sides of the central wall. Each panel storage area is adapted to retain a plurality of panels each positioned generally parallel to the central

wall and generally perpendicular to the base. The one or more generally horizontal separating planks extend away from the central wall and are adapted to retain upper edge regions of panels stored in the rack. The one or more generally horizontal supporting planks extend away from the central wall and are adapted to support lower edges of panels stored in the rack. At least one panel is positioned in a stored position on the rack by securing the panel between at least one desired supporting plank and at least one desired separating plank.

Further, certain embodiments of the invention provide a rack for storing generally sheet-like panels. The rack comprises a generally planar base, a generally planar central wall, one or more separating planks, and one or more supporting planks. The generally planar central wall extends away from the base in a generally perpendicular fashion. The rack has panel storage areas on both sides of the central wall. Each panel storage area is adapted to retain a plurality of panels each positioned generally parallel to the central wall and generally perpendicular to the base. The one or more separating planks are each adapted to be secured to the central wall so as to extend away from the central wall and are each adapted to retain upper edge regions of panels stored in the rack. The one or more supporting planks are each adapted to be secured to the central wall so as to extend away from the central wall and are each adapted to support lower edges of panels stored in the rack.

Brief Description of the Drawings

Figure 1 is a side view of a laminated glass panel;

Figure 2 is a schematic, perspective view of a rack in accordance with certain embodiments of the invention;

Figure 3 is a schematic, perspective view of a separating plank of the rack of Figure 2;

Figure 4 is a schematic, perspective view of a supporting plank of the rack of Figure 2; and

Figure 5 is a schematic, perspective view of the rack of Figure 2 showing panels stored thereon in accordance with certain embodiments of the invention.

Detailed Description of Preferred Embodiments

The following detailed description is to be read with reference to the drawings, in which like elements in different drawings have like reference numerals. The drawings, which are not necessarily to scale, depict selected embodiments and are not intended to limit the scope of the invention. Skilled artisans will recognize that the examples provided herein have many useful alternatives that fall within the scope of the invention.

The structure of the system is generally referred to herein as a rack; however, the structure can also be referred to as a shelving unit, a support stand, a framework, or using other like terms. Preferably, the structure of the system (i.e., the rack) is adapted for securely storing laminated glass panels, particularly during autoclave processing. The rack, however, can also be configured and used for storing other objects, as well as provide an exceptional storage system for a wide variety of non-autoclave applications.

In preferred embodiments, the invention provides a rack for storing generally sheet-like panels, e.g., laminated glass panels. A representative laminated glass panel

10 is illustrated in Figure 1. Preferably, the panel 10 includes a first sheet-like substrate 12 bonded to a second sheet-like substrate 14 by an intermediate tear-resistant plastic film (or "interlayer") 16. Typically, the substrates 12, 14 are glass sheets. However, plastic and other substrate materials can also be used. The rack can be used quite advantageously for storing laminated glass panels 10 before, during, and after the racked panels are processed in an autoclave. Therefore, the rack preferably is sized, shaped, and configured to fit (e.g., when fully loaded with laminated glass panels 10) inside a glass laminating autoclave. Preferably, the rack is provided with a plurality of wheels (e.g., castor wheels extending downwardly from a base of the rack), such that the loaded rack can be easily rolled into and out of a glass laminating autoclave. Further, the rack preferably is adapted to withstand the rigors of repeated use inside a glass laminating autoclave (i.e., the rack is desirably constructed of material that is durable to repeated glass autoclave processing). In particular, the rack preferably is constructed of material having a melting point greater than about 300 °C (or greater than a maximum temperature reached inside a desired autoclave during its operation).

Figure 2 is a schematic perspective view of a rack 18 in accordance with certain embodiments of the invention. In these embodiments, the rack 18 includes a generally planar base 20 and a generally planar central wall 22. Preferably, the base 20 is generally horizontal and the central wall 22 is generally vertical, at least when the rack 18 is in an operable position. In preferred embodiments, the central wall 22 extends away from the base 20 in a generally perpendicular fashion. For example, when the base 20 is horizontal and the central wall 22 is vertical, the central wall 22 preferably extends upwardly (e.g., vertically) away from the base 20. In preferred embodiments,

the central wall 22 is fixed rigidly to (and in some cases is integral to) the base 20.

Preferably, the rack 18 has panel storage areas 24 on both sides of the central wall 22. In embodiments like those exemplified in Figure 2, the storage areas 24 on both sides of the central wall 22 have substantially the same storage capabilities (i.e., they have substantially the same dimensions and configurability). In Figure 2, the central wall 22 is situated on (i.e., is joined to the base 20 at, and extends upwardly from) a central axis of the base 20. Each panel storage area 24 is adapted to retain a plurality of panels (not shown) each positioned generally parallel to the central wall 22 and generally perpendicular to the base 20. Preferably, the rack 18 is adapted for carrying two or more tiers of panels (i.e., two or more "storage tiers") on each side of the central wall 22. Further, the rack 18 preferably can be adjusted such that each storage tier on each side of the central wall 22 can accommodate (or comprise) panels of different size. In fact, in preferred embodiments, the rack 18 can be adjusted such that one storage tier on a given side of the central wall 22 can accommodate (or comprise) panels of one size, while another storage tier on the same side of the central wall 22 can accommodate (or comprise) panels of a different size. Thus, the rack 18 offers an exceptional degree of flexibility, e.g., in terms of its ability to be configured (e.g., assembled and/or adjusted) in various ways. This flexibility allows the rack 18 to accommodate various combinations of panels having various different sizes. The flexibility of the rack 18 makes it exceptionally well-suited for maximizing the number of panels that can be stored on the rack 18.

As noted above, the rack 18 preferably comprises a base 20 and a central wall 22 extending away from, and being generally perpendicular to, the base 20. Preferably,

the rack 18 is also provided with one or more separating planks 26 each adapted for being secured to the central wall 22, e.g., so as to extend away from the central wall 22 desirably in a generally perpendicular fashion (i.e., such that when a separating plank 26 is secured to the central wall 22, such plank 26 is generally perpendicular to the wall 22). Preferably, each separating plank 26 is adapted to retain upper edge regions of panels (not shown) stored in the rack 18.

The rack 18 also is preferably provided with one or more supporting planks 28 each adapted to retain lower edge regions of panels (not shown) stored in the rack 18. In certain preferred embodiments, the rack 18 includes one or more supporting planks 28 each adapted for being secured to the central wall 22, e.g., so as to extend away from the central wall 22 desirably in a generally perpendicular fashion (i.e., such that when a supporting plank 28 is secured to the central wall 22, such plank 28 is generally perpendicular to the wall 22).

In certain embodiments wherein the rack 18 is assembled, the rack 18 comprises one or more separating tiers each defined by one or more separating planks 26 attached to, and extending away from, the central wall 22, and one or more supporting tiers each defined by one or more supporting planks 28 extending away from the central wall 22. Here, the separating 26 and supporting 28 planks preferably extend generally horizontally away from the central wall 22. In these embodiments, the separating planks 26 are adapted to retain upper edge regions of panels stored in the rack 18, while the supporting planks 28 are adapted to support lower edges of panels stored in the rack 18.

Figure 3 illustrates a schematic perspective view of one of the separating planks 26 of the rack 18 shown in Figure 2. Preferably, each separating plank 26 is adapted to be (and in certain embodiments is) removably mounted to the central wall 22. For example, one end of each separating plank 26 is preferably adapted for being removably attached to the central wall 22 (e.g., at various heights on the wall 22). This allows the rack 18 to be configured (e.g., assembled and/or adjusted) to accommodate panels of various different sizes. Methods for removably attaching a separating plank 26 to the central wall 22 are described below in further detail. In certain particularly preferred embodiments, each separating plank 26 is a cantilever beam attached (preferably removably attached) at one end to the central wall 22.

Preferably, each separating plank 26 includes a plurality of separating fingers 30. In embodiments of this nature, the separating fingers 30 are spaced apart along a length (e.g., along a major length) of each separating plank 26. These separating fingers 30 are adapted to separate upper edge regions of adjacent panels stored in the rack 18. The separating fingers 30 desirably are rotatably disposed on (or "carried rotatably by") the separating planks 26. In certain embodiments, each separating finger 30 is a flat, rectangular-shaped plate. Preferably, the fingers 30 are formed of a material having a melting point greater than 300 °C (or greater than the maximum temperature reached during autoclave operations). In certain preferred embodiments, the fingers 30 are formed of a plastic material having such a melting point.

In certain preferred embodiments, each separating plank 26 comprises a rigid beam 32 extending from (and being rigidly joined to) a rigid base flange 34 that can be attached rigidly and removably to the central wall 22. Preferably, the rigid beam 32 is a

tubular member (e.g., tubular steel) defining a square central cavity, while the rigid base flange 34 is a flat plate (e.g., a square steel plate). Various other configurations can, of course, be used. In certain embodiments, one end of the rigid beam 32 is welded to the rigid base flange 34. In Figure 3, spaced apart from, and extending parallel to, the rigid beam 32 is a rod (not visible in Figure 3) that carries (e.g., rotatably) the separating fingers 30. The fingers 30 desirably each define a mount opening, and the rod desirably extends through the aligned mount openings of the fingers 30. Preferably, the rod (which may also be formed of steel) has substantially the same length as the rigid beam 32 so that separating fingers 30 can be positioned along substantially the entire length of the plank 26. In certain embodiments, one end of the rod is coupled (e.g., welded) to the rigid base flange 34. Preferably, the other end of the rod is coupled (e.g., linked) to a corresponding end of the rigid beam 32 via a connecting segment (shown in Figures 2 and 3), preferably made of steel and formed in the shape of a flat, rectangular bar. In certain embodiments, the mount opening of each separating finger 30 is located near a minor edge of the finger 30 and facilitates rotation of each separating finger 30 into either an upward position 36 (held from rotating downward by contact with the rigid beam 32) or a downward position 38. Preferably, the fingers 30 are separated on the rod by one or more spacers, e.g., washers, (not visible in Figure 3).

Figure 4 illustrates a schematic perspective view of one of the supporting planks 28 of the rack 18 shown in Figure 2. As noted above, the rack 18 includes one or more supporting planks 28 extending away from the central wall 22. Each tier defined by one or more supporting planks 28 provides a foundation on which a tier of panels (i.e., a storage tier) can be supported. As can be appreciated with reference to Figure 2, the

base 20 of the rack 18 preferably comprises a plurality of supporting planks 28 defining a first supporting tier. In Figure 2, these base supporting planks 28 are a permanent part of (i.e., are integral to) the base 20. Preferably, the rack 18 also includes one or more upper supporting planks 28 (e.g., planks defining a foundation for a second or higher storage tier) adapted for being removably attached to the central wall 22 (e.g., at various heights on the wall 22). This is perhaps best appreciated with reference to Figure 2, wherein the first tier supporting planks 28 (i.e., the base supporting planks 28) are an integral part of the base, while the second tier supporting planks 28 are removably attached to the central wall 22. Various manners in which the supporting planks 28 can be removably attached to the central wall 22 are described below in further detail.

Thus, in preferred embodiments, the rack 18 includes a plurality of supporting planks 28 adapted for being removably attached to the central wall 22. Preferably, each such supporting plank 28 is adapted for being removably mounted to the central wall 22 at various heights. This provides the rack 18 with exceptional flexibility in terms of being adjustable to accommodate multiple tiers of panels of various different sizes. In certain particularly preferred embodiments, each of these supporting planks 40 is a cantilever beam attached (e.g., removably attached) at one end to the central wall 22.

In certain embodiments, each supporting plank 28 comprises a panel-engagement pad 40. Preferably, a panel-engagement pad 40 forms an upper portion of each supporting plank 28. Each panel-engagement pad 40 is adapted to engage lower edges of panels stored in the rack 18. Thus, when laminated glass panels, for example, are stored in the rack 18, the bottom edges of the panels will rest upon the underlying

panel-engagement pads 40. The pads 40 desirably comprise (e.g., are formed of) a flexible material, which preferably is adapted for preventing breakage of panels resting on such a pad. In certain embodiments, each panel-engagement pad 40 comprises a rubberlike material. Preferably, each panel-engagement pad 40 is formed of a material that is durable to repeated glass autoclave processing. For example, each pad 40 is preferably formed of a durable material having a melting point greater than 300 °C (or greater than the maximum temperature reached during autoclave operations).

In certain preferred embodiments, each supporting plank 28 comprises one or more receiving members (e.g., receiving beams) 42. In Figure 2, each upper supporting plank 28 includes a receiving member 42 to which a panel-engagement pad 40 is removably attached. In some embodiments, the receiving member 42 itself provides the supporting plank 28 with adequate structural stability. In other embodiments, each supporting plank 28 also comprises a rigid beam 44 to which the receiving member 42 may be welded or otherwise joined. In certain particularly preferred embodiments, the lower portion of each upper supporting plank 28 includes the rigid beam 44 (e.g., formed of tubular metal, preferably steel) joined to the receiving member 42 such that the receiving member 42 extends along the top of the rigid beam 44.

Each upper supporting plank 28 in Figure 2 comprises a sleeve 46 that is attached removably to the central wall 22. Here the sleeve 46 (which defines one end of the plank 28) is adapted to be mounted removably to the central wall 22. In certain embodiments, the sleeve 46 comprises a rectangular plate (e.g., of steel) having a C-shaped cross-sectional configuration and includes first 48 and second 50 substantially parallel base flanges. These base flanges 48, 50 are connected by a third base flange

51 that is generally perpendicular to the first and second base flanges 48, 50. This configuration allows the sleeve to be fitted snuggly over (and around three walls of) a square beam of the central wall 22, as shown in Figures 2 and 4. In Figure 2, the sleeve 46 is joined (e.g., welded) to one end of the rigid beam 44 and is attached rigidly and removably to the central wall 22.

As mentioned above, a panel-engagement pad 40 preferably, though not necessarily, defines an upper portion of each supporting plank 28. In certain particularly preferred embodiments, each panel-engagement pad 40 is removably attached to the receiving member 42 of a supporting plank 28. Accordingly, any pad 40 that is damaged or otherwise no longer desired can be readily replaced with a new pad 40. One particular embodiment of this nature, as shown, involves the receiving member 42 removably retaining a bottom portion of the pad 40. As shown in Figure 4, the pad 40 can have wide top and bottom portions connected by a narrow neck, such that the narrow neck can be slid into a gap (or "slot") extending along a top surface of the receiving member 42, such that the wide bottom portion of the pad 40 is trapped within a central cavity of the tubular receiving member 42. In certain embodiments, a cotter pin (not shown) is inserted through holes in the receiving member 42 to hold the pad 40 in place on the plank 28 once the pad 40 is mounted on the receiving member 42.

In Figure 2, the separating planks 26 and the supporting planks 28 extend substantially the same distance away from the central wall 22 as does the base 20. This is particularly advantageous as it allows panels to be stored in the rack along substantially the entire distance between the central wall 22 and a distal end (i.e., an end furthest from the central wall 22) of the base 20. In other embodiments, however,

the rack 18 may comprise planks 26, 28 of shorter length. For example, one may wish to accommodate particularly large panels and smaller panels on the same side of the central wall 22. This could be accomplished using the present rack 18, even if the large panels have a height nearly equaling that of the rack 18. For example, by using planks 26, 28 that do not extend entirely to a distal end of the base 20, it is possible to retain such large and small panels on the same side of the rack 18 (e.g., the small panels could be stored adjacent the central wall 22 while the large panels are stored further from the wall 22). As such, one or more tiers of separating planks 26 extending horizontally only part of the distance between the central wall 22 and a distal end of the base 20 could be used to retain the upper edges of the small panels. Optionally, a second tier of small panels could be positioned above this first tier of small panels. Another tier of separating planks 26 extending horizontally substantially the entire distance between the central wall 22 and the distal end of the base 20 could then be used to retain the upper edges of the large panels.

Preferably, the rack 18 has a central wall 22 that is generally planar. This wall 22 can be provided in various different configurations. In certain preferred embodiments, the wall 22 comprises a plurality of spaced-apart generally vertical beams, as exemplified in Figure 2. Preferably, the beams are formed of tubular steel. The beams are adapted for receiving separating planks 26 and supporting planks 28. Preferably, the central wall 22 includes one or more beams 52 adapted for receiving separating planks 26 at various heights and one or more beams 54 adapted for receiving supporting planks 28 at various heights. In these embodiments, the central wall 22 preferably includes one set (i.e., a plurality) of beams 52 for receiving separating planks

26 and another set of beams 54 for receiving supporting planks 28. In embodiments of this nature, no separating plank 26 is mounted on a beam to which a supporting plank 28 is attached. This, however, is by no means required or intended to limit the invention as such. It is fully contemplated that the rack 18 may alternatively include a central wall including one or more vertical beams that could each accommodate both types of planks 26, 28.

Thus, the central wall 22 preferably comprises a plurality of beams 52 adapted for receiving separating planks 26 and a plurality of beams 54 adapted for receiving supporting planks 28. This allows separating planks 26 and supporting planks 28 to be mounted at various lateral positions on the central wall 22 as well as at various heights. In certain preferred embodiments, the central wall 22 comprises at least four, and perhaps more preferably at least eight, beams each adapted for receiving separating and/or supporting planks 26, 28. In these embodiments, the separating planks 26 and supporting planks 28 can be mounted at a wide variety of lateral positions on the central wall 22 as well as at various heights.

In Figure 3, each beam 52 that is adapted for receiving separating planks 26 defines a plurality of front openings 56 spaced-apart along a vertical length (preferably along a major vertical length) of a front face (or a "front wall") 58 of such beam 52. Preferably, each front opening 56 extends through the front face 58 of such beam 52 and through a back face (or "back wall") of the beam 52. Each front opening 56 is preferably adapted to receive a bolt 60, which is used to rigidly and releasably attach a separating plank 26 (preferably to attach the base flange 34 of such plank 26) to one of the beams 52. In certain embodiments, the bolt 60 is sized to extend from the base

flange 34 (e.g., through an opening therein, with the bolt head trapped against the flange 34) of the separating plank 26, through one of the front openings 56, through a corresponding opening in the back face of the beam 52, and into a corresponding nut (not visible in Figure 3), thereby securing the separating plank 26 to the beam 52. Thus, the base flange 34 of the separating plank 26 can be fastened rigidly and removably to the beam 52. By spacing the front openings 56 along a vertical length of the front face 54 of the beam 52, the separating planks 26 can be attached to the central wall 22 at various heights. Further, by providing a number of laterally-spaced beams 52 that are adapted for receiving separating planks 26, the separating planks 26 can be attached to the central wall 22 at various lateral positions. These features contribute extraordinary flexibility to certain preferred embodiments of the rack 18.

In Figure 4, each beam 54 that is adapted for receiving supporting planks 28 defines a plurality of side openings 62 spaced-apart along a vertical length of a side face (or "side wall") 64 of the beam 54. Preferably, each side opening 62 extends through the side face 64 of the beam 54 and through an opposing side face of the beam 54. In certain embodiments, each side opening 62 is adapted to receive a fastener, which is used to releasably attach a supporting plank 28 (preferably to attach base flanges 48, 50 of such plank 28) to one of the beams 54. Preferably, each fastener is a linchpin 66. In certain embodiments, each linchpin 66 is sized to extend from the first base flange 48 (e.g., through an opening therein, with the head of the linchpin 66 trapped against the first flange 48) of the supporting plank 28, through one of the side openings 62, through a corresponding opening in the opposing side face of the beam

54, and through an opening in the second base flange 50 of the supporting plank 28, thereby securing the supporting plank 28 to the beam 54.

Thus, two fasteners, e.g., linchpins 66, are preferably used to adjoin one end of each upper supporting plank 28 to one of the beams 54. Preferably, the two fasteners extend through respective side openings 62 in such beam 54. By using two fasteners, the end of each such plank 28 is fastened rigidly and removably to the beam 54 without any significant freedom to move pivotally. By spacing the side openings 62 along a vertical length of the side face 64 of the beam 54, supporting planks 28 can be attached to the central wall 22 at various heights. Further, by providing a number of laterally-spaced beams 54 that are adapted for receiving supporting planks 28, supporting planks 28 can be attached to the central wall 22 at various lateral positions. These features contribute further flexibility to certain preferred embodiments of the rack 18.

Thus, in certain embodiments, the invention provides a rack 18 for storing generally sheet-like panels 10, an embodiment of which is shown in Figure 5. Preferably, the rack 18 has a generally horizontal base 20 and a generally vertical central wall 22 extending upwardly away from the base 20. The rack 18 has panel storage areas 24 on both sides of the central wall 22, and each panel storage area 24 is adapted to retain a plurality of panels 10 each positioned generally parallel to the central wall 22 and generally perpendicular to the base 20. Preferably, the rack 18 includes one or more generally horizontal separating planks 26 each attached to the central wall 22, such that each separating plank 26 extends away from the central wall 22 and is adapted to retain upper edge regions of panels 10 stored in the rack. In certain embodiments, a first tier of separating planks 26 is positioned a first vertical distance

above a first tier of supporting planks 28 (which in embodiments like that shown in Figure 2 are integral to the base 20), so as to accommodate a first tier of panels 10 (i.e., a first storage tier) stored in the rack 18.

In certain embodiments, the rack 18 is configured to accommodate a second tier of panels 10 (i.e., a second storage tier) stored in the rack 18, as also shown in Figure 5. As such, a second tier of supporting planks 28 is positioned above the first tier of separating planks 26, and a second tier of separating planks 26 is positioned a second vertical distance above the second tier of supporting planks 28, so as to accommodate a second tier of panels 10 stored in the rack 18. In certain preferred embodiments, separating planks 26 and supporting planks 28 are attached to the central wall 22 such that the rack 18 accommodates at least two such storage tiers on each side of the central wall 22. In embodiments comprising a rack 18 having first and second storage tiers, the first and second tiers of separating planks 26 and the second tier of supporting planks 28 preferably can be positioned at different heights on the central wall 22. In embodiments of this nature, the first and second vertical distances can be adjusted; allowing panels of different sizes to be stored in the rack, and allowing panels of one size to be stored in one storage tier while panels of another size are stored in another storage tier.

In some embodiments, additional storage tiers are provided on the rack 18. For example, a third tier of supporting planks 28 can be positioned above a second tier of separating planks 26, and a third tier of separating planks 26 can be positioned a third vertical distance above the third tier of supporting planks 28, so as to accommodate a

third tier of panels stored in the rack 18. The desired number of storage tiers will typically depend on the sizes of the panels that are to be loaded on the rack 18.

In certain embodiments, as shown in Figure 5, a first tier of one or more panels 10 is positioned in a stored position on the rack 18 by securing the one or more panels 10 between at least one supporting plank 28 and at least one separating plank 26. Each such panel 10 preferably is positioned in the stored position by placing (e.g., resting) a lower edge of the panel 10 on top of a panel-engagement pad 40 that defines an upper portion of a supporting plank 28. Preferably, an upper edge region of each such panel 10 is secured between two adjacent separating fingers 30 on a separating plank 26. In certain embodiments, each supporting plank 28 and each separating plank 26 extend substantially the same distance away from the central wall 22 as does the base 20. In embodiments of this nature, if necessary, panels 10 can be positioned in the rack 18 along substantially an entire distance between the central wall 22 and a distal end of the base 20.

Preferably, as represented in Figure 5, a first tier of panels 10 is secured between a first tier of supporting planks 28 and a first tier of separating planks 26. In certain embodiments, a second tier of panels 10 is secured between a second tier of supporting planks 28 and a second tier of separating planks 26. In some cases, at least two tiers of panels 10 are secured on each side of the rack's central wall 22. In certain embodiments, as also shown in Figure 5, the rack 18 may be configured and loaded such that one storage tier on a given side of the central wall 22 comprises panels 10 of one size, while another storage tier on the same side of the central wall 22 comprises

panels 10 of a different size. In certain embodiments, once panels 10 are loaded on the rack 18, the loaded rack is positioned (e.g., moved) inside a glass laminating autoclave.

The racking system of the invention provides many appealing advantages, e.g., for manufacturers of laminated glass panels. In certain embodiments, the rack 18 comprises four primary elements, the base 20, the central wall 22, the separating planks 26, and the supporting planks 28. In these embodiments, the configuration (e.g., assembly, disassembly, and/or reconfiguration) of the rack 18 is particularly simple and straight-forward. Further, the separating 26 and supporting 28 planks can be attached rigidly and removably to the rack 18 using fasteners (e.g., bolts 60 and linchpins 66) that can be manipulated (e.g., installed, removed, and/or replaced) by hand or with common tools. The rack 18, in preferred embodiments, is constructed without complicated irremovable brackets to further support the planks 26, 28. Finally, the rack 18 in preferred embodiments requires no welding between the planks 26, 28 and the central wall 22. Thus, the rack 18 can generally be assembled and disassembled as many times as necessary.

Further, there are essentially an endless number of different ways in which the rack 18 can be configured and used. For example, the rack 18 could be repeatedly used for a single panel size. As such, the rack 18 could be configured to hold the number of tiers that maximizes the number of panels of a given size and shape on the rack 18. The rack 18 may also be used repeatedly for two or more panel sizes. As described above, the rack 18 could be configured to hold the number of tiers that maximizes the number of such panels on the rack 18. With preferred embodiments of the present rack, one has great flexibility in deciding how panels should be distributed

on the rack 18. A further embodiment involves the rack 18 being used repeatedly for panels of various different sizes and shapes. Here, the rack 18 is particularly advantageous because it can be configured and reconfigured in any fashion (e.g., via the placement of the separating 26 and supporting 28 planks) to maximize the number of panels that can be stored on the rack 18 or to otherwise achieve a desired loading configuration.

As noted above, certain embodiments of the invention provide a rack 18 comprising separating and supporting planks 26, 28 attached rigidly and removably to the central wall 22. Therefore, there are essentially no fabrication costs associated with reconfiguring the rack 18, as the rack 18 can be easily modified. For example, if it is desired to relocate one or more separating and/or supporting planks 26, 28 to different locations on the central wall 22, or if it is desired to add and/or remove one or more planks 26, 28, such modifications would not involve additional tooling costs. Rather, additional planks 26, 28 can simply be kept on hand. Further, adjusting the configuration of the rack is particularly easy and requires very little labor. In developing this adaptable racking system, in contrast to more rigidly built systems (e.g., box-like racks), unique design considerations were considered. In particular, the structural integrity of the planks (particularly the supporting planks 28), as well as the interconnection between the planks and the central wall 22, had to be able to withstand the weight of stored panels. The weight of stored panels can be particularly high, especially when compared to other types of rack cargo. After extensive testing, it was determined that the planks 28 and their connections to the central wall 22 could withstand the loads involved in autoclaving laminated glass panels.

While preferred embodiments of the present invention have been described, it should be understood that a variety of changes, adaptations, and modifications can be made therein without departing from the spirit of the invention and the scope of the appended claims.